JC17 Rec'd PCT/PTO 11 JUL 2001

FORM PTO-1390 (Modified) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE
(REV 11-98)

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 112740-242

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR: 09/889100

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE99/02524	12 August 1999	11 January 1999

TITLE OF INVENTION
PASSIVE MICROPHONE WITH WIRELESS TRANSMISSION

APPLICANT(S) FOR DO/EO/US
Jürgen Michel et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☒ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Submission of Drawings Figures 1-2 on one sheet

PCTUS1/REV03

JC18 Rec'd PCT/PTO 11 JUL 2001

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 09/889100	INTERNATIONAL APPLICATION NO. PCT/DE99/02524	ATTORNEY'S DOCKET NUMBER 0112740-242

21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS	PTO USE ONLY
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$1,000.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO	**$860.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	**$710.00**		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$690.00**		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	**$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =		**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).		**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	18 - 20 =	0	x $18.00	**$0.00**	
Independent claims	- 3 =	0	x $80.00	**$0.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$860.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).** ☐				**$0.00**	
SUBTOTAL =				**$860.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$860.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**	
TOTAL FEES ENCLOSED =				**$860.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$860.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees. A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

Thomas C. Basso, Esq.

NAME

46,541

REGISTRATION NUMBER

July 11, 2001

DATE

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE

OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANTS:	Jürgen Michel et al.	DOCKET NO: 112740-242
SERIAL NO:		GROUP ART UNIT:
		EXAMINER:
INTERNATIONAL APPLICATION NO:		PCT/DE99/02524
INTERNATIONAL FILING DATE:		12 August 1999
INVENTION:	PASSIVE MICROPHONE WITH WIRELESS TRANSMISSION	

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

SPECIFICATION

TITLE

PASSIVE MICROPHONE WITH WIRELESS TRANSMISSION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a microphone for detecting acoustic signals, converting the acoustic signals into electrical signals and transmitting the electrical signals to a receiving unit.

Description of the Prior Art

Known microphones of this type are usually supplied with power via a connecting line or a cable, respectively, via which the electrical signals are transmitted to the receiving unit, or have active electronic components and their own power supply in the form of a battery. Microphones in which the electrical signals are transmitted to a receiving unit via a wireless type of transmission, for example radio microphones, must have their own battery or their own accumulator which provides the necessary power for signal processing and signal transmission.

The receiving unit is, for example, a telephone base station which is connected to a landline network, but can also be a mobile station of a wireless telecommunication system. If the microphone is integrated in a headset, a cable link between the headset and the telephone base station is disadvantageous in many applications due to the restriction of the freedom of movement. In the German Patent Document No. 195 20 674, it is proposed to send signals of a piezoelectric sensor to an evaluating device. In this case, however, it must be assumed that the transmitter has its own power supply. However, providing the microphone of the headset with its own power supply in the form of a battery is too much to ask of a user because of the increase in weight.

In hands-free systems in motor vehicles, for example, neither of the two known solutions is practicable because, on the one hand, a cable link between microphone and telephone restricts the freedom of movement and vision of the driver and, on the other hand, prolonged wearing of a heavy microphone can be disturbing when driving a car.

Further, the microphone of a hands-free system in a motor vehicle should be as close to the mouth of the speaker as possible in order to keep the level of disturbances caused by loud driving noises as low as possible. In the Swiss Patent Document No. CH 664 659, a throat microphone is disclosed which is effectively partitioned off against the effects of external sound. The resonator of the throat microphone is formed by piezoelectric materials. The voltages occurring across the piezoelectric material due to sound vibrations are picked up and sent to a transmission unit either by wire or wirelessly. The disadvantageous factors in this implementation are mainly two things: on the one hand, it is generally more difficult to amplify the

human voice by means of the sounds formed in the throat than the spoken word. In the case of a wireless transmission of the low-frequency voice signals, on the other hand, the problems would occur which usually occur in the case of unmodulated signals. As an example, propagation characteristics or bandwidths are only mentioned here. If a modulated signal is to be used, the throat microphone would need its own power supply which would necessarily lead to disadvantages of using same due to, for example, increased weight as mentioned above.

An object of the present invention, therefore, is to provide a microphone for transmitting sound information to a receiving unit, which microphone is constructed in a simple and lightweight manner and, at the same time, provides for the wireless transmission of the sound information to the receiving unit.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a passive microphone for wirelessly transmitting sound information to a receiving unit, which has a piezoelectric device for receiving and storing excitation energy from the receiving unit and for wirelessly transmitting electrical signals, converted from detected acoustic signals, to the receiving unit.

Using a piezoelectric device makes it possible, on the one hand, to receive and store excitation energy from the receiving unit and, on the other hand, to wirelessly transmit electrical signals bearing sound information to the receiving unit, thus providing a simple and lightweight construction of the microphone. Further, by storing excitation energy in the piezoelectric device, it is not necessary for the microphone to have its own power supply in the form of a battery or an accumulator.

The microphone of the present invention is a passive microphone, i.e., it is not provided with its own power supply and the transmission of electrical signals bearing sound information from the microphone to the receiving unit is carried out via continuous or discontinuous power transmission in the form of an electromagnetic signal via the receiving unit. The microphone of the present invention is, thus, constructed in a lightweight and simple manner and capable of effectively providing wireless transmission of electrical signals.

The piezoelectric device stores the excitation energy from the receiving unit in the form of mechanical vibrations. Furthermore, a particularly lightweight and simple construction can be achieved if the piezoelectric device is used, at the same time, for storing the electromagnetic excitation energy, for detecting acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information. In this case, the passive microphone of the present invention which includes the piezoelectric device can result in a particularly simple, lightweight and inexpensive construction.

The piezoelectric device can include, for example, a piezoelectric diaphragm. The excitation energy from the receiving unit can then be absorbed via the antenna of the microphone and converted into mechanical vibrations of the diaphragm. At the same time, the vibrating diaphragm can detect acoustic signals which are also modulated as mechanical vibrations onto the vibrations of the diaphragm caused by the excitation energy. The modulated vibrations are converted into electrical signals by the piezoelectric diaphragm and transmitted to the receiving unit. The piezoelectric diaphragm can be composed of, for example, a crystal or lithiumniobate. Crystal, in particular, has a very high Q factor as energy store.

As an alternative to the piezoelectric diaphragm, the piezoelectric device can include a surface acoustic wave delay line, a resonator or the like. In these embodiments, too, a single device is, thus, used for storing the electromagnetic excitation energy, for detecting acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information, as a result of which a simple construction is possible.

As an alternative to constructing the piezoelectric device essentially of a single element, the piezoelectric device can comprise a device for detecting acoustic signals and a device for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information. Separating the functions into two different elements makes it possible to achieve greater sensitivity and better transmission quality. The device for detecting the acoustic signals can include, for example, a diaphragm, preferably composed of metal. The

device for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals including sound information preferably includes a piezoelectric element such as, for example, a surface acoustic wave delay line or a resonator such as, for example, a piezoelectric diaphragm. The diaphragm for detecting acoustic signals can be bonded, for example, to the piezoelectric element, such as to the surface acoustic wave delay line or to the resonator, in order to be able to modulate the detected sound signals converted into mechanical vibrations directly onto the vibrations in the piezoelectric element which are caused by the excitation energy of the receiving unit. The modulated vibrations are then converted into electrical signals by the piezoelectric element and are transmitted to the receiving unit.

It is preferable in the two embodiments described above that one or a further device for detecting acoustic signals is provided and is arranged in such a manner that the detected acoustic signals are differentially converted into electrical signals bearing sound information. As a result, the sensitivity of the microphone of the present invention can be considerably enhanced. Furthermore, it is preferable that a device for compensating for disturbance variables is provided in order to compensate, for example, for the influence of temperature fluctuations or the like.

The electromagnetic excitation energy from the receiving unit can be transmitted to the piezoelectric device of the microphone of the present invention in the form of discontinuous or continuous excitation signals. The piezoelectric device can be designed in such a manner that it receives the electromagnetic excitation energy from the receiving unit in the form of short high-frequency signals. The electromagnetic excitation signals from the receiving unit can also be periodically repeated high-frequency signals. It is preferable that the piezoelectric device receives the electromagnetic excitation energy from the receiving unit in the form of excitation signals having a large bandwidth-time product. As an alternative, the piezoelectric device can receive the magnetic excitation energy from the receiving unit in the form of a continuous frequency-modulated excitation signal.

Additional features and advantages of the present invention are described in, and will be apparent from, the Detailed Description of the Preferred Embodiment and the Drawings.

DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a diagrammatic representation of a microphone of the present invention and an associated receiving unit; and

Fig. 2 shows an embodiment of a piezoelectric device of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 diagrammatically shows a passive microphone 1 of the present invention and a corresponding receiving unit 6. The passive microphone 1 of the present invention includes a piezoelectric device 4 for receiving and storing excitation energy from the receiving unit 6 and for wirelessly transmitting electrical signals converted from the detected acoustic signals to the receiving unit 6.

In the preferred embodiment as shown in Fig. 1, the piezoelectric device includes a device 2 for detecting acoustic signals and a device 3 for converting the detected acoustic signals into electrical signals bearing sound information. The microphone 1 also includes an antenna 5, connected to the piezoelectric device 4, for receiving the excitation energy from the receiving unit 6 and for sending out the electrical signals bearing sound information to the receiving unit 6.

The receiving unit 6 also includes an antenna 7 for sending out the excitation energy in the form of excitation signals and for receiving the electrical signals from the microphone 1.

As is shown in Fig. 1, the receiving unit 6 transmits the excitation energy, for example in the form of discontinuous excitation pulses, to the microphone 1. The excitation pulses are received by the piezoelectric device 4 of the microphone 1 via the antenna 5 and are stored, e.g., as mechanical vibrations. For this purpose, the piezoelectric device 4 includes, for example, a piezoelectric element as is shown in Fig. 2. The piezoelectric element includes a piezoelectric diaphragm 8 on which, for example, reflectors 10 composed of deposited metal strips are provided.

Furthermore, a converter 9, which is coupled to the antenna 5, for converting the received excitation pulses into a surface acoustic wave is provided on the diaphragm 8. The converter 9 is connected to a ground. Similar to the reflectors 10, the converter 9 includes metal patterns, e.g., of aluminum, applied to the diaphragm 8.

When a high-frequency excitation is received from the receiving unit 6, the diaphragm is excited into vibrations via the converter 9 due to the formation of a surface acoustic wave. The vibrations expand on the top of the diaphragm in both directions toward the reflector fields 10 and are reflected by these so that a standing wave is formed in the case of resonance. In this manner, the excitation energy of the excitation pulse from the receiving unit 6 is stored in the form of mechanical vibrations. The piezoelectric element reflects the energy temporarily stored as mechanical vibrations back to the receiving unit 6 in the form of a decaying vibration via the antenna 5 as shown diagrammatically in Fig. 1. This decaying vibration is received in the receiving unit 6 via the antenna 7, and is detected, demodulated and analyzed.

The resonant frequency of the piezoelectric element and thus of the decaying vibration, which is reflected back to the receiving unit 6 by the piezoelectric element, changes under the influence of a strain because the speed of propagation of the surface acoustic wave and the distances between the two electrodes of the converter 9 change. In the embodiment shown in Fig. 1, the diaphragm 8 with the reflectors 10 is used as the device 3 for storing excitation energy from the receiving unit 6 and for converting the detected acoustic signals into electrical signals bearing sound information. The device 2 for detecting acoustic signals can be formed, for example, by a diaphragm, not shown, preferably composed of metal, which is bonded to the diaphragm 8. The diaphragm used as the detection device 2 absorbs sound waves and converts them into mechanical vibrations. The mechanical vibrations are transferred from the diaphragm detecting the acoustic signals to the piezoelectric diaphragm 8. In this process, corresponding vibrations of the vibration of the piezoelectric diaphragm 8 caused by the electromagnetic excitation from the receiving unit 6 are modulated onto the acoustic

signals. The modulated vibration is converted back into electrical signals via the converter 9 and transmitted as electromagnetic signal back to the receiving unit 6 via the antenna 5.

As an alternative to the piezoelectric diaphragm 8 with the reflectors 10 and the converter 9, shown in Fig. 2, a surface acoustic wave delay line can be used as the device 3 for storing electromagnetic excitation energy from the receiving unit 6 and for converting the detected acoustic signals into electrical signals bearing sound information. In a surface acoustic wave delay line, electromagnetic excitation energy from the receiving unit 6 is also stored as mechanical vibration. A detection device 2 for detecting acoustic signals, which is coupled to the surface acoustic wave delay line, converts received acoustic signals, i.e., sound waves, into mechanical vibrations which are transferred to the surface acoustic wave delay line. This causes transit-time effects in the mechanical vibration caused by the excitation energy from the receiving unit 6, as a result of which the acoustic signals are modulated onto this mechanical vibration.

The acoustic signals detected by the device 2 are thus converted into electrical signals bearing sound information by the device 3 and modulated onto the piezoelectric element so that the decaying harmonic vibration reflected back bears the sound information modulated on. This sound information modulated on can be detected and analyzed in the receiving unit 6.

It is preferred that the piezoelectric device 4 combines the devices 2 and 3 in one element which both detects the acoustic signals and also converts the detected acoustic signals into electrical signals bearing sound information. The piezoelectric diaphragm 8 with the surface acoustic wave resonance pattern, shown in Fig. 2, is used as the single element forming the device 4. In this case, the piezoelectric diaphragm 8 detects incoming acoustic signals in the manner of a pressure sensor. The standing wave in the piezoelectric element, which is excited by an excitation pulse from the receiving unit 6, is modulated by the acoustic signals so that the decaying vibration reflected back to the receiving unit 6 after the end of the excitation pulse includes the corresponding sound information. This makes it possible to provide a very durable

passive microphone for wireless transmission of sound information which has a simple and lightweight construction.

The microphone 1 of the present invention can be constructed as a passive component, i.e., without its own power supply in the form of a battery or the like, since the energy of the excitation pulses from the receiving unit 6 absorbed by the piezoelectric element, can be stored and used for transmitting the sound information.

To avoid heterodyning of the excitation signals with the signals bearing the sound information, transmitted by the microphone 1, the piezoelectric element can be excited discontinuously, for example by a pulsed excitation signal. However, it is also possible to utilize certain continuous excitation signals. An impulse response in the form of a decaying vibration, which is extended over a very long period in the time domain, is generated, and transmitted back to the receiving unit 6, in particular, if the diaphragm 8 is a crystal diaphragm which has a very high Q factor.

Furthermore, the piezoelectric diaphragm 8 can be composed of lithiumniobate.

Instead of the piezoelectric diaphragm 8 with the surface acoustic wave resonant pattern, shown in Fig. 2, a surface acoustic wave delay line can also be used as the single element of the device 4. The surface acoustic wave delay line can both detect the acoustic signals and convert the detected acoustic signals into electrical signals bearing sound information.

If the piezoelectric device 4 is used for detecting the acoustic signals, a second piezoelectric device can be provided in order to provide for differential processing and conversion of the detected acoustic signals and thus to increase the sensitivity, for example for compensating for temperature fluctuations. If a separate device 2 for detecting acoustic signals is provided, a second device 2 for detecting acoustic signals can be provided in order to provide for differential conversion of the detected acoustic signals into electrical signals for the same purpose. In addition or as an alternative, a device for compensating for further disturbance variables can also be present.

As is shown diagrammatically in Fig. 1, the electromagnetic excitation energy can include discontinuous excitation pulses which are sent out by the receiving unit 6

and are correspondingly received by the microphone 1 of the present invention. The excitation pulses from the receiving unit 6 can be, for example, short high-frequency signals which, if necessary, are periodically repeated. It is preferred in this arrangement that the excitation signal from the receiving unit 6 has a large bandwidth-time product. In an embodiment, continuous frequency-modulated excitation signals can be used.

Since the passive microphone 1 of the present invention is constructed in a very lightweight and durable manner, it can be attached, for example, to a spectacles frame. The antenna 5 of the microphone 1 can be formed, for example, by one of the earpieces of the spectacles or by the frame of one of the spectacle lenses. The microphone can be attached, for example, to the transition between the earpiece, used as antenna, and the spectacle lens frame.

As an alternative, the microphone of the present invention can be attached to a holder which is detachably attached to the spectacle frame and which can extend downward in the direction of the mouth of the wearer from the spectacle lens frame. In this case, the holder can be constructed as the antenna 5 of the microphone 1.

The passive microphone 1 of the present invention can also be suitable for use in a wireless headset such that voice signals can be transmitted to a telephone base station or a telephone mobile station. The microphone of the present invention can be constructed to be very lightweight and rugged which results in varied and specialized applications.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

The present invention relates to a passive microphone for wirelessly transmitting sound information to a receiving unit. The passive microphone includes a piezoelectric device for receiving and storing excitation energy from the receiving unit and for wirelessly transmitting electrical signals, converted from detected acoustic

signals, to the receiving unit. The passive microphone, i.e., without its own power supply, provides for a lightweight and, at the same time, rugged and durable construction which can be utilized in a variety of different applications, particularly in telephone applications.

In the claims:

On amended page 12, cancel line 1, and substitute the following left-hand justified heading therefor:

We Claim as Our Invention:

Please cancel 1-18, without prejudice, and substitute the following claims therefor:

19. A passive microphone for wirelessly transmitting sound information to a receiving unit, comprising:

an antenna that receives an amount of electromagnetic excitation energy from the receiving unit; and

a piezoelectric device that is connected to the antenna for receiving and storing the electromagnetic excitation energy from the antenna such that at least one acoustic signal is detected and converted into at least one electrical signal which includes sound information, wherein the electrical signals are wirelessly transmitted via the antenna to the receiving unit.

20. A passive microphone as claimed in claim 19, wherein the piezoelectric device temporarily stores the electromagnetic excitation energy from the receiving unit in a form of mechanical vibrations.

21. A passive microphone as claimed in claim 19, wherein the piezoelectric device stores the electromagnetic excitation energy such that the piezoelectric device detects the at least one acoustic signal and converts it into the at least one electrical signal.

22. A passive microphone as claimed in claim 19, wherein the piezoelectric device comprises a piezoelectric diaphragm that has a surface acoustic wave resonant pattern.

23. A passive microphone as claimed in claim 22, wherein the diaphragm is composed of a crystal.

24. A passive microphone as claimed in claim 22, wherein the diaphragm is composed of lithiumniobate.

25. A passive microphone as claimed in claim 19, wherein the piezoelectric device comprises a surface acoustic wave delay line.

26. A passive microphone as claimed in claim 19, wherein the piezoelectric device comprises a first device for detecting the at least one acoustic signal and a second device for storing the electromagnetic excitation energy and converting the at least one acoustic signal into the at least one electrical signal.

27. A passive microphone as claimed in claim 26, wherein the first device comprises a diaphragm.

28. A passive microphone as claimed in claim 26, wherein the diaphragm is composed of a metal.

29. A passive microphone as claimed in claim 26, wherein the second device comprises a diaphragm that has a surface acoustic wave resonant structure.

30. A passive microphone as claimed in claim 26, wherein the second device comprises a surface acoustic wave delay line.

31. A passive microphone as claimed in claim 19, further comprising:

at least one additional piezoelectric device for detecting acoustic signals, wherein the pizoelectric device and the at least one additional piezoelectric

device are configured such that the detected acoustic signals are differentially converted into the electrical signals.

32. A passive microphone as claimed in claim 19, wherein the passive microphone further comprises a device that compensates for disturbance variables.

33. A passive microphone as claimed in claim 19, wherein the piezoelectric device receives the electromagnetic excitation energy from the receiving unit in a form of short high-frequency signals.

34. A passive microphone as claimed in claim 19, wherein the piezoelectric device receives the electromagnetic excitation energy from the receiving unit in a form of periodically repeated high-frequency signals.

35. A passive microphone as claimed in claim 19, wherein the piezoelectric device receives the electromagnetic excitation energy from the receiving unit in a form of excitation signals that have a large bandwidth-time product.

36. A passive microphone as claimed in claim 19, wherein the piezoelectric device receives the electromagnetic excitation energy from the receiving unit in a form of a continuous frequency-modulated excitation signal.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "**Version With Markings To Show Changes Made**".

In addition, the present amendment cancels original claims 1-18 in favor of new claims 19-36. Claims 19-36 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-18 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC §§103, 102, 103 or 112. Indeed, the cancellation of claims 1-18 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-18.

Early consideration on the merits is respectfully requested.

Respectfully submitted,

(Reg. No. 46,541)

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Attorneys for Applicants

VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

~~**Description**~~

~~**Passive microphone with wireless transmission**~~

SPECIFICATION

TITLE

PASSIVE MICROPHONE WITH WIRELESS TRANSMISSION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a microphone for detecting acoustic signals, converting the acoustic signals into electrical signals and transmitting the electrical signals to a receiving unit.

Description of the Prior Art

Known microphones of this type are usually supplied with power via a connecting line or a cable, respectively, via which the electrical signals are transmitted to the receiving unit, or have active electronic components and their own power supply in the form of a battery. Microphones in which the electrical signals are transmitted to a receiving unit via a wireless type of transmission, for example radio microphones, must have their own battery or their own accumulator which provides the necessary power for signal processing and signal transmission.

The receiving unit is, for example, a telephone base station which is connected to a landline network, but can also be a mobile station of a wireless telecommunication system. If the microphone is integrated in a headset, a cable link between the headset and the telephone base station is disadvantageous in many applications due to the restriction of the freedom of movement. In ~~patent specification~~ the German Patent Document No. 195 20 674, ~~therefore,~~ it is proposed to send signals of a piezoelectric sensor to an evaluating device. In this case, however, it must be assumed that the

transmitter has its own power supply. However, providing the microphone of the headset with its own power supply in the form of a battery is too much to ask of a user because of the increase in weight.

In hands-free systems in motor vehicles, for example, neither of ~~thetwo~~ the two known solutions is practicable because, on the one hand, a cable link between microphone and telephone restricts the freedom of movement and vision of the driver and, on the other hand, prolonged wearing of a heavy microphone ~~is~~ can be disturbing when driving a car.

~~On the other hand, however~~ Further, the microphone of a hands-free system in a motor vehicle should be as close to the mouth of the speaker as possible in order to keep the level of disturbances caused by loud driving noises as low as possible. In ~~patent specification~~ the Swiss Patent Document No. CH 664 659, ~~therefore,~~ a throat microphone is ~~proposed~~ disclosed which is effectively partitioned off against the effects of external sound. The resonator ~~is here~~ of the throat microphone is formed by piezoelectric materials. The voltages occurring across the piezoelectric material due to sound vibrations are picked up and sent to a transmission unit either by wire or wirelessly. The disadvantageous factors in this implementation are mainly two things: on the one hand, it is generally more difficult to amplify the human voice by means of the sounds formed in the throat than the spoken word. In the case of a wireless transmission of the low-frequency voice signals, on the other hand, the problems would occur which usually occur in the case of unmodulated signals. As an example, propagation characteristics or bandwidths are only mentioned here. ~~As soon as~~ If a modulated signal is to be used, the throat microphone ~~again needs~~ would need its own power supply ~~with all the disadvantages already mentioned above.~~ which would necessarily lead to disadvantages of using same due to, for example, increased weight as mentioned above.

~~It is thus the~~ An object of the present invention, therefore, is to provide a microphone for transmitting sound information to a receiving unit, which microphone is constructed in a simple and lightweight manner and, at the same time, provides for the wireless transmission of the sound information to the receiving unit.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to ~~This object is achieved by~~ a passive microphone for wirelessly transmitting sound information to a receiving unit ~~according to claim 1~~, which has a piezoelectric device for receiving and storing excitation energy from the receiving unit and for wirelessly transmitting electrical signals, converted from detected acoustic signals, to the receiving unit.

Using a piezoelectric device makes it possible, on the one hand, to receive and store excitation energy from the receiving unit and, on the other hand, to wirelessly transmit electrical signals bearing sound information to the receiving unit ~~which provides for~~, thus providing a simple and lightweight construction of the microphone ~~according to the invention. Storing~~. Further, by storing excitation energy in the piezoelectric device ~~dispenses with the necessity of providing the microphone with~~, it is not necessary for the microphone to have its own power supply in the form of a battery or an accumulator.

The microphone ~~according to~~ of the present invention is a passive microphone, i.e., it is not provided with its own power supply and the transmission of electrical signals bearing sound information from the microphone to the receiving unit is carried out ~~by means of~~ via continuous or discontinuous power transmission in the form of an electromagnetic signal ~~by means of~~ via the receiving unit. The microphone ~~according to~~ of the present invention is, thus, constructed in a lightweight and simple manner and~~, nevertheless, provides for the~~ capable of effectively providing wireless transmission of electrical signals.

The piezoelectric device ~~advantageously~~ stores the excitation energy from the receiving unit in the form of mechanical vibrations. Furthermore, a particularly lightweight and simple construction can be achieved if the piezoelectric device is used, at the same time, for storing the electromagnetic excitation energy, for detecting acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information. In this case, the passive microphone ~~according to~~ of the present invention ~~essentially only comprises~~ which includes the piezoelectric device~~,~~

~~as a~~ can result ~~of which~~ in a particularly simple, lightweight and inexpensive construction ~~is possible~~.

The piezoelectric device can~~, therefore, essentially consist~~ include, for example, ~~of~~ a piezoelectric diaphragm. The excitation energy from the receiving unit ~~is~~ can then be absorbed via the antenna of the microphone and converted into mechanical vibrations of the diaphragm. At the same time, the vibrating diaphragm can detect acoustic signals which are also modulated as mechanical vibrations onto the vibrations of the diaphragm caused by the excitation energy. The modulated vibrations are converted into electrical signals by the piezoelectric diaphragm and transmitted to the receiving unit. The piezoelectric diaphragm can ~~consist of~~ be composed of, for example, a crystal or ~~of~~ lithiumniobate. Crystal, in particular, has a very high Q factor as energy store.

As an alternative to the piezoelectric diaphragm, the piezoelectric device can ~~essentially consist of~~ include a surface acoustic wave delay line ~~or also of~~, a resonator or the like. In these embodiments, too, a single device is, thus, used for storing the electromagnetic excitation energy, for detecting acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information, as a result of which a simple construction is possible.

As an alternative to constructing the piezoelectric device essentially of a single element, the piezoelectric device can comprise a device for detecting acoustic signals and a device for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information. Separating the functions into two different elements makes it possible to achieve greater sensitivity and better transmission quality. The device for detecting the acoustic signals can ~~essentially consist~~ include, for example, ~~of~~ a diaphragm, ~~advantageously~~ preferably composed of metal. The device for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals ~~bearing~~ including sound information ~~advantageously consists of~~ preferably includes a piezoelectric element such as, for example, a surface acoustic wave delay line or a resonator such as, for example, a piezoelectric diaphragm. The diaphragm for

detecting acoustic signals can be bonded, for example, to the piezoelectric element, ~~that is to say, for example,~~ such as to the surface acoustic wave delay line or to the resonator, in order to be able to modulate the detected sound signals converted into mechanical vibrations directly onto the vibrations in the piezoelectric element which are caused by the excitation energy of the receiving unit. The modulated vibrations are then converted into electrical signals by the piezoelectric element and are transmitted to the receiving unit.

~~Furthermore, it is of advantage~~ It is preferable in the two embodiments described above ~~if~~ that one or a further device for detecting acoustic signals is provided and is arranged in such a manner that the detected acoustic signals are differentially converted into electrical signals bearing sound information. As a result, the sensitivity of the microphone ~~according to~~ of the present invention can be considerably enhanced. Furthermore, it is ~~of advantage if~~ preferable that a device for compensating for disturbance variables is provided in order to compensate, for example, for the influence of temperature fluctuations or the like.

The electromagnetic excitation energy from the receiving unit can be transmitted to the piezoelectric device of the microphone ~~according to~~ of the present invention in the form of discontinuous or continuous excitation signals. The piezoelectric device can be designed in such a manner that it receives the electromagnetic excitation energy from the receiving unit in the form of short high-frequency signals. The electromagnetic excitation signals from the receiving unit can also be periodically repeated high-frequency signals. It is ~~also of advantage if~~ preferable that the piezoelectric device receives the electromagnetic excitation energy from the receiving unit in the form of excitation signals having a large bandwidth-time product. As an alternative, ~~it may be of advantage if~~ the piezoelectric device ~~receives~~ can receive the magnetic excitation energy from the receiving unit in the form of a continuous frequency-modulated excitation signal.

~~In the text which follows,~~ Additional features and advantages of the present invention ~~will be explained in greater detail by means of a preferred exemplary embodiment, referring to the attached drawings, in which~~ are described in, and will be

apparent from, the Detailed Description of the Preferred Embodiment and the Drawings.

DESCRIPTION OF THE DRAWINGS

~~Figure~~ Fig. 1 shows a diagrammatic representation of a microphone ~~according to~~ of the present invention and an associated receiving unit~~,~~; and

~~Figure~~ Fig. 2 shows an ~~exemplary~~ embodiment of a piezoelectric device ~~according to the invention.~~ of the present invention.

~~Figure~~ DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 diagrammatically shows a passive microphone 1 ~~according to~~ of the present invention and a corresponding receiving unit 6. The passive microphone 1 ~~according to~~ of the present invention ~~comprises~~ includes a piezoelectric device 4 for receiving and storing excitation energy from the receiving unit 6 and for wirelessly transmitting electrical signals converted from the detected acoustic signals to the receiving ~~unit 6.~~ unit 6.

In the ~~exemplary~~ preferred embodiment as shown in Fig. 1, the piezoelectric device ~~comprises~~ includes a device 2 for detecting acoustic signals and a device 3 for converting the detected acoustic signals into electrical signals bearing sound information. The microphone 1 also ~~exhibits~~ includes an antenna 5, connected to the piezoelectric device 4, for receiving the excitation energy from the receiving unit 6 and for sending out the electrical signals bearing sound information to the receiving unit 6.

The receiving unit 6 also ~~comprises~~ includes an antenna 7 for sending out the excitation energy in the form of excitation signals and for receiving the electrical signals from the microphone 1.

As is shown in ~~figure 1~~ Fig. 1, the receiving unit 6 transmits the excitation energy, for example in the form of discontinuous excitation pulses, to the microphone 1. The excitation pulses are received by the piezoelectric device 4 of the microphone 1 via the antenna 5 and are stored, e.g., as mechanical vibrations. For this purpose, the piezoelectric device 4 ~~comprises~~ includes, for example, a piezoelectric element as is shown in ~~figure 2~~ Fig. 2. The piezoelectric element ~~consists of~~ includes a piezoelectric

diaphragm 8 on which, for example, reflectors 10 ~~consisting~~ composed of deposited metal strips are provided.

Furthermore, a converter 9, which is coupled to the antenna 5, for converting the received excitation pulses into a surface acoustic wave is provided on the diaphragm 8. The converter 9 is connected to a ground. Similar to the reflectors 10, the converter 9 ~~consists of~~ includes metal patterns, e.g., of aluminum, applied to the diaphragm 8.

When a high-frequency excitation is received from the receiving unit 6, the diaphragm is excited into vibrations via the converter 9 due to the formation of a surface acoustic wave. The vibrations expand on the top of the diaphragm in both directions toward the reflector fields 10 and are reflected by these so that a standing wave is formed in the case of resonance. In this manner, the excitation energy of the excitation pulse from the receiving unit 6 is stored in the form of mechanical vibrations. The piezoelectric element reflects the energy temporarily stored as mechanical vibrations back to the receiving unit 6 in the form of a decaying vibration via the antenna 5 as shown diagrammatically in ~~figure 1~~ Fig. 1. This decaying vibration is received in the receiving unit 6 via the antenna 7, and is detected, demodulated and analyzed.

The resonant frequency of the piezoelectric element and thus of the decaying vibration, which is reflected back to the receiving unit 6 by the piezoelectric element, changes under the influence of a strain because the speed of propagation of the surface acoustic wave and the distances between the two electrodes of the converter 9 change. In the embodiment shown in ~~figure 1~~ Fig. 1, the diaphragm 8 with the reflectors 10 is used as the device 3 for storing excitation energy from the receiving unit 6 and for converting the detected acoustic signals into electrical signals bearing sound information. The device 2 for detecting acoustic signals can be formed, for example, by a diaphragm, not shown, ~~advantageously~~ preferably composed of metal, which is bonded to the diaphragm 8. The diaphragm used as the detection device 2 absorbs sound waves and converts them into mechanical vibrations. The mechanical vibrations are transferred from the diaphragm detecting the acoustic signals to the piezoelectric

diaphragm 8. In this process, corresponding vibrations of the vibration of the piezoelectric diaphragm 8 caused by the electromagnetic excitation from the receiving unit 6 are modulated onto the acoustic signals. The modulated vibration is converted back into electrical signals via the converter 9 and transmitted as electromagnetic signal back to the receiving unit 6 via the antenna 5.

As an alternative to the piezoelectric diaphragm 8 with the reflectors 10 and the converter 9, shown in ~~figure 2~~ Fig. 2, a surface acoustic wave delay line can be used as the device 3 for storing electromagnetic excitation energy from the receiving unit 6 and for converting the detected acoustic signals into electrical signals bearing sound information. In a surface acoustic wave delay line, electromagnetic excitation energy from the receiving unit 6 is also stored as mechanical vibration. A detection device 2 for detecting acoustic signals, which is coupled to the surface acoustic wave delay line, converts received acoustic signals, i.e., sound waves, into mechanical vibrations which are transferred to the surface acoustic wave delay line. This causes transit-time effects in the mechanical vibration caused by the excitation energy from the receiving unit 6, as a result of which the acoustic signals are modulated onto this mechanical vibration.

The acoustic signals detected by the device 2 are thus converted into electrical signals bearing sound information by the device 3 and modulated onto the piezoelectric element so that the decaying harmonic vibration reflected back bears the sound information modulated on. This sound information modulated on can be detected and analyzed in the receiving unit 6.

It is preferred that the piezoelectric device 4 combines the devices 2 and 3 in one element which both detects the acoustic signals and ~~particularly advantageous if the piezoelectric device 4 combines the devices 2 and 3 in one element which both detects the acoustic signals and~~

also converts the detected acoustic signals into electrical signals bearing sound information. The piezoelectric diaphragm 8 with the surface acoustic wave resonance pattern, shown in ~~figure 2~~ Fig. 2, is used as the single element forming the device 4. In this case, the piezoelectric diaphragm 8 detects incoming acoustic signals in the

manner of a pressure sensor. The standing wave in the piezoelectric element, which is excited by an excitation pulse from the receiving unit 6, is modulated by the acoustic signals so that the decaying vibration reflected back to the receiving unit 6 after the end of the excitation pulse ~~bears~~ includes the corresponding sound information. This makes it possible to provide a very ~~rugged~~ durable passive microphone for wireless transmission of sound information which has a simple and lightweight construction.

The microphone 1 ~~according to~~ of the present invention ~~is~~ can be constructed as a passive component, i.e., without its own power supply in the form of a battery or the like, since the energy of the excitation pulses from the receiving unit 6 ~~is~~ absorbed by the piezoelectric element, ~~is~~ can be stored and ~~is~~ used for transmitting the sound information.

To avoid heterodyning of the excitation signals with the signals bearing the sound information, transmitted by the microphone 1, the piezoelectric element ~~is~~ can be excited discontinuously, for example by a pulsed excitation signal. However, it is also possible to ~~find advantageous~~ utilize certain continuous excitation signals. An impulse response in the form of a decaying vibration, which is extended over a very long period in the time domain, is generated, and transmitted back to the receiving unit 6, in particular, if the diaphragm 8 is a crystal diaphragm which has a very high Q factor.

Furthermore, the piezoelectric diaphragm 8 can ~~essentially consist~~ be composed of lithiumniobate.

Instead of the piezoelectric diaphragm 8 with the surface acoustic wave resonant pattern, shown in ~~figure 2~~ Fig. 2, a surface acoustic wave delay line can also be used as the single element of the device 4. The surface acoustic wave delay line can both detect the acoustic signals and convert the detected acoustic signals into electrical signals bearing sound information.

If the piezoelectric device 4 is used for detecting the acoustic signals, a second piezoelectric device can be provided in order to provide for differential processing and conversion of the detected acoustic signals and thus to increase the sensitivity, for example for compensating for temperature fluctuations. If a separate device 2 for

detecting acoustic signals is provided, a second device 2 for detecting acoustic signals can be provided in order to provide for differential conversion of the detected acoustic signals into electrical signals for the same purpose. In addition or as an alternative, a device for compensating for further disturbance variables can also be present.

As is shown diagrammatically in ~~figure 1~~ Fig. 1, the electromagnetic excitation energy can ~~consist of~~ include discontinuous excitation pulses which are sent out by the receiving unit 6 and are correspondingly received by the microphone 1 ~~according to~~ of the present invention. The excitation pulses from the receiving unit 6 can be, for example, short high-frequency signals which, if necessary, are periodically repeated. It is ~~of advantage~~ preferred in this arrangement ~~if~~ that the excitation signal from the receiving unit 6 has a large bandwidth-time product. ~~Another possibility is to use~~ In an embodiment, continuous frequency-modulated excitation signals can be used.

Since the passive microphone 1 ~~according to~~ of the present invention is constructed in a very lightweight and ~~rugged~~ durable manner, it can be attached, for example, to a spectacles frame. The antenna 5 of the microphone 1 can be formed, for example, by one of the earpieces of the spectacles or by the frame of one of the spectacle lenses. The microphone can be attached, for example, to the transition between the earpiece, used as antenna, and the spectacle lens frame.

As an alternative, the microphone ~~according to~~ of the present invention can be attached to a holder which is detachably attached to the spectacle frame and which ~~extends~~ can extend downward in the direction of the mouth of the wearer from the spectacle lens frame. In this case, the holder can be constructed as the antenna 5 of the microphone 1.

The passive microphone 1 ~~according to~~ of the present invention ~~is~~ can also be suitable for use in a wireless headset ~~by means of which~~ such that voice signals ~~are~~ can be transmitted to a telephone base station or a telephone mobile station. The microphone ~~according to~~ of the present invention can be constructed to be very lightweight and rugged which results in varied and specialized applications.

~~Abstract~~ Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be

made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

~~Passive microphone with wireless transmission~~

ABSTRACT OF THE DISCLOSURE

The present invention relates to a passive microphone ~~(1)~~ for wirelessly transmitting sound information to a receiving unit~~(6), comprising~~. The passive microphone includes a piezoelectric device ~~(4)~~ for receiving and storing excitation energy from the receiving unit ~~(6)~~ and for wirelessly transmitting electrical signals, converted from detected acoustic signals, to the receiving unit ~~6. Constructing the microphone (1) according to the invention as a passive component, i.e.~~. The passive microphone, i.e., without its own power supply, provides for a lightweight and, at the same time, rugged and durable construction which ~~results in considerable advantages~~ can be utilized in a variety of different applications, particularly in telephone applications.

~~(Figure 1)~~

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UNDER THE PATENT COOPERATION TREATY-CHAPTER II

SUBMISSION OF DRAWINGS

APPLICANTS: Jürgen Michel et al. DOCKET NO: 0112740-242

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INVENTION: PASSIVE MICROPHONE WITH WIRELESS TRANSMISSION

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Applicants herewith submit one sheet (Figs. 1-2) of drawings for the above-referenced PCT application.

Respectfully submitted,

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FIG 1

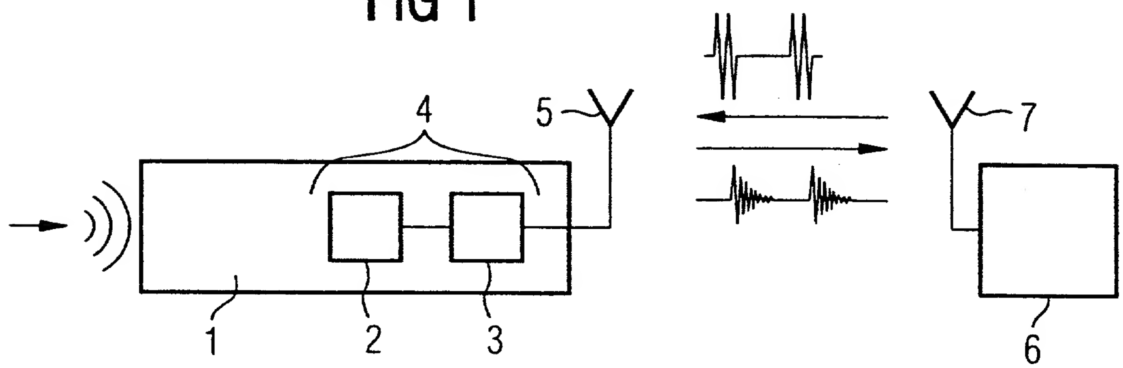
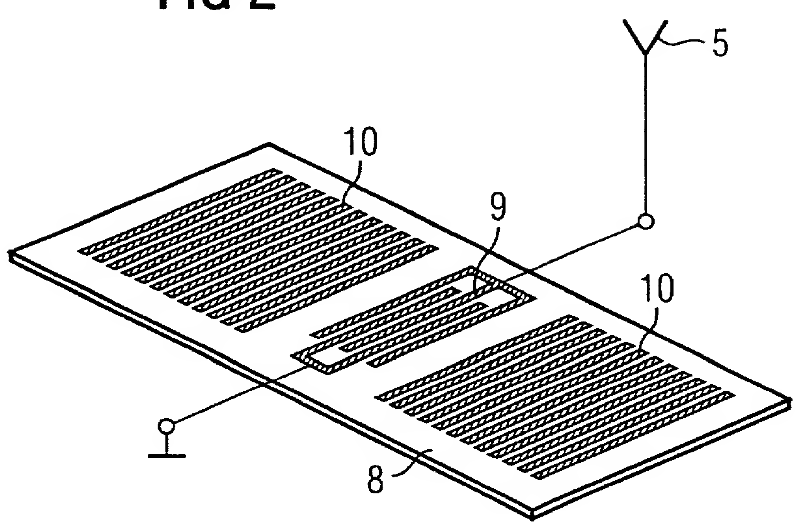


FIG 2



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Description

Passive microphone with wireless transmission

The present invention relates to a microphone for detecting acoustic signals, converting the acoustic signals into electrical signals and transmitting the electrical signals to a receiving unit.

Known microphones of this type are usually supplied with power via a connecting line or a cable, respectively, via which the electrical signals are transmitted to the receiving unit, or have active electronic components and their own power supply in the form of a battery. Microphones in which the electrical signals are transmitted to a receiving unit via a wireless type of transmission, for example radio microphones, must have their own battery or their own accumulator which provides the necessary power for signal processing and signal transmission.

The receiving unit is, for example, a telephone base station which is connected to a landline network, but can also be a mobile station of a wireless telecommunication system. If the microphone is integrated in a headset, a cable link between the headset and the telephone base station is disadvantageous in many applications due to the restriction of the freedom of movement. In patent specification 195 20 674, therefore, it is proposed to send signals of a piezoelectric sensor to an evaluating device. In this case, however, it must be assumed that the transmitter has its own power supply. However, providing the microphone of the headset with its own power supply in the form of a battery is too much to ask of a user because of the increase in weight. In hands-free systems in motor vehicles, for example, neither of the

AMENDED SHEET

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two known solutions is practicable because, on the one hand,

a cable link between microphone and telephone restricts the freedom of movement and vision of the driver and, on the other hand, prolonged wearing of a heavy microphone is disturbing when driving a car. On the other hand, however, the microphone of a hands-free system in a motor vehicle should be as close to the mouth of the speaker as possible in order to keep the level of disturbances caused by loud driving noises as low as possible. In patent specification CH 664 659, therefore, a throat microphone is proposed which is effectively partitioned off against the effects of external sound. The resonator is here formed by piezoelectric materials. The voltages occurring across the piezoelectric material due to sound vibrations are picked up and sent to a transmission unit either by wire or wirelessly. The disadvantageous factors in this implementation are mainly two things: on the one hand, it is generally more difficult to amplify the human voice by means of the sounds formed in the throat than the spoken word. In the case of a wireless transmission of the low-frequency voice signals, on the other hand, the problems would occur which usually occur in the case of unmodulated signals. As an example, propagation characteristics or bandwidths are only mentioned here. As soon as a modulated signal is used, the throat microphone again needs its own power supply with all the disadvantages already mentioned above.

It is thus the object of the present invention to provide a microphone for transmitting sound information to a receiving unit, which microphone is constructed in a simple and lightweight manner and, at the same time, provides for the wireless transmission of the sound information to the receiving unit.

This object is achieved by a passive microphone for wirelessly transmitting sound information to a receiving unit according to claim 1, which has a

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piezoelectric device for receiving and storing excitation energy from the receiving unit and for wirelessly transmitting electrical signals, converted from detected acoustic signals, to the receiving unit.

Using a piezoelectric device makes it possible, on the one hand, to receive and store excitation energy from the receiving unit and, on the other hand, to wirelessly transmit electrical signals bearing sound information to the receiving unit which provides for a simple and lightweight construction of the microphone according to the invention. Storing excitation energy in the piezoelectric device dispenses with the necessity of providing the microphone with its own power supply in the form of a battery or an accumulator.

The microphone according to the invention is a passive microphone, i.e. it is not provided with its own power supply and the transmission of electrical signals bearing sound information from the microphone to the receiving unit is carried out by means of continuous or discontinuous power transmission in the form of an electromagnetic signal by means of the receiving unit. The microphone according to the invention is thus constructed

in a lightweight and simple manner and, nevertheless, provides for the wireless transmission of electrical signals.

The piezoelectric device advantageously stores the excitation energy from the receiving unit in the form of mechanical vibrations. Furthermore, a particularly lightweight and simple construction can be achieved if the piezoelectric device is used, at the same time, for storing the electromagnetic excitation energy, for detecting acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information. In this case, the passive microphone according to the invention essentially only comprises the piezoelectric device, as a result of which a particularly simple, lightweight and inexpensive construction is possible. The piezoelectric device can, therefore, essentially consist, for example, of a piezoelectric diaphragm. The excitation energy from the receiving unit is then absorbed via the antenna of the microphone and converted into mechanical vibrations of the diaphragm. At the same time, the vibrating diaphragm can detect acoustic signals which are also modulated as mechanical vibrations onto the vibrations of the diaphragm caused by the excitation energy. The modulated vibrations are converted into electrical signals by the piezoelectric diaphragm and transmitted to the receiving unit. The piezoelectric diaphragm can consist of crystal or of lithiumniobate. Crystal, in particular, has a very high Q factor as energy store. As an alternative to the piezoelectric diaphragm, the piezoelectric device can essentially consist of a surface acoustic wave delay line or also of a resonator. In these embodiments, too, a single device is thus used for storing the electromagnetic excitation energy, for detecting acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information, as a result of which a simple construction is possible.

As an alternative to constructing the piezoelectric device essentially of a single element, the piezoelectric device can comprise a device for detecting acoustic signals and a device for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information. Separating the functions into two different elements makes it possible to achieve greater sensitivity and better transmission quality. The device for detecting the acoustic signals can essentially consist, for example, of a diaphragm, advantageously of metal. The device for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information advantageously consists of a piezoelectric element such as, for example, a surface acoustic wave delay line or a resonator such as, for example, a piezoelectric diaphragm. The diaphragm for detecting acoustic signals can be bonded, for example, to the piezoelectric element, that is to say, for example, to the surface acoustic wave delay line or to the resonator, in order to be able to modulate the detected sound signals converted into mechanical vibrations directly onto the vibrations in the piezoelectric element which are caused by the excitation energy of the receiving unit. The modulated vibrations are then converted into electrical signals by the piezoelectric element and are transmitted to the receiving unit.

Furthermore, it is of advantage in the two embodiments above if one or a further device for detecting acoustic signals is provided and is arranged in such a manner that the detected acoustic signals are differentially converted into electrical signals bearing sound information. As a result, the sensitivity of the microphone according to the invention can be considerably enhanced. Furthermore, it is of advantage if a device for compensating for

disturbance variables is provided in order to compensate, for example, for the influence of temperature fluctuations or the like.

The electromagnetic excitation energy from the receiving unit can be transmitted to the piezoelectric device of the microphone according to the invention in the form of discontinuous or continuous excitation signals. The piezoelectric device can be designed in such a manner that it receives the electromagnetic excitation energy from the receiving unit in the form of short high-frequency signals. The electromagnetic excitation signals from the receiving unit can also be periodically repeated high-frequency signals. It is also of advantage if the piezoelectric device receives the electromagnetic excitation energy from the receiving unit in the form of excitation signals having a large bandwidth-time product. As an alternative, it may be of advantage if the piezoelectric device receives the magnetic excitation energy from the receiving unit in the form of a continuous frequency-modulated excitation signal.

In the text which follows, the present invention will be explained in greater detail by means of a preferred exemplary embodiment, referring to the attached drawings, in which

Figure 1 shows a diagrammatic representation of a microphone according to the present invention and an associated receiving unit, and

Figure 2 shows an exemplary embodiment of a piezoelectric device according to the invention.

Figure 1 diagrammatically shows a passive microphone 1 according to the present invention and a corresponding receiving unit 6. The passive microphone 1 according to the invention comprises a piezoelectric device 4 for receiving and storing excitation energy from the receiving unit 6

and for wirelessly transmitting electrical signals converted from the detected acoustic signals to the receiving unit 6. In the exemplary embodiment shown, the piezoelectric device comprises a device 2 for detecting acoustic signals and a device 3 for converting the detected acoustic signals into electrical signals bearing sound information. The microphone 1 also exhibits an antenna 5, connected to the piezoelectric device 4, for receiving the excitation energy from the receiving unit 6 and for sending out the electrical signals bearing sound information to the receiving unit 6.

The receiving unit 6 also comprises an antenna 7 for sending out the excitation energy in the form of excitation signals and for receiving the electrical signals from the microphone 1.

As is shown in figure 1, the receiving unit 6 transmits the excitation energy, for example in the form of discontinuous excitation pulses, to the microphone 1. The excitation pulses are received by the piezoelectric device 4 of the microphone 1 via the antenna 5 and are stored, e.g. as mechanical vibrations. For this purpose, the piezoelectric device 4 comprises, for example, a piezoelectric element as is shown in figure 2. The piezoelectric element consists of a piezoelectric diaphragm 8 on which, for example, reflectors 10 consisting of deposited metal strips are provided.

Furthermore, a converter 9, which is coupled to the antenna 5, for converting the received excitation pulses into a surface acoustic wave is provided on the diaphragm 8. The converter 9 is connected to a ground. Similar to the reflectors 10, the converter 9 consists of metal patterns, e.g. of aluminum, applied to the diaphragm 8.

When a high-frequency excitation is received from the receiving unit 6, the diaphragm is excited into vibrations via the converter 9 due to the formation of a surface acoustic wave. The vibrations expand on the top of the diaphragm in both directions toward the reflector fields 10 and are reflected by these so that a standing wave is formed in the case of resonance. In this manner, the excitation energy of the excitation pulse from the receiving unit 6 is stored in the form of mechanical vibrations. The piezoelectric element reflects the energy temporarily stored as mechanical vibrations back to the receiving unit 6 in the form of a decaying vibration via the antenna 5 as shown diagrammatically in figure 1. This decaying vibration is received in the receiving unit 6 via the antenna 7, and is detected, demodulated and analyzed.

The resonant frequency of the piezoelectric element and thus of the decaying vibration, which is reflected back to the receiving unit 6 by the piezoelectric element, changes under the influence of a strain because the speed of propagation of the surface acoustic wave and the distances between the two electrodes of the converter 9 change. In the embodiment shown in figure 1, the diaphragm 8 with the reflectors 10 is used as the device 3 for storing excitation energy from the receiving unit 6 and for converting the detected acoustic signals into electrical signals bearing sound information. The device 2 for detecting acoustic signals can be formed, for example, by a diaphragm, not shown, advantageously of metal, which is bonded to the diaphragm 8. The diaphragm used as the detection device 2 absorbs sound waves and converts them into mechanical vibrations. The mechanical vibrations are transferred from the diaphragm detecting the acoustic signals to the piezoelectric diaphragm 8. In this process, corresponding vibrations of the vibration of the piezoelectric diaphragm 8 caused by the electromagnetic excitation from the receiving unit 6 are

modulated onto the acoustic signals. The modulated vibration is converted back into electrical signals via the converter 9 and transmitted as electromagnetic signal back to the receiving unit 6 via the antenna 5.

As an alternative to the piezoelectric diaphragm 8 with the reflectors 10 and the converter 9, shown in figure 2, a surface acoustic wave delay line can be used as the device 3 for storing electromagnetic excitation energy from the receiving unit 6 and for converting the detected acoustic signals into electrical signals bearing sound information. In a surface acoustic wave delay line, electromagnetic excitation energy from the receiving unit 6 is also stored as mechanical vibration. A detection device 2 for detecting acoustic signals, which is coupled to the surface acoustic wave delay line, converts received acoustic signals, i.e. sound waves, into mechanical vibrations which are transferred to the surface acoustic wave delay line. This causes transit-time effects in the mechanical vibration caused by the excitation energy from the receiving unit 6, as a result of which the acoustic signals are modulated onto this mechanical vibration.

The acoustic signals detected by the device 2 are thus converted into electrical signals bearing sound information by the device 3 and modulated onto the piezoelectric element so that the decaying harmonic vibration reflected back bears the sound information modulated on. This sound information modulated on can be detected and analyzed in the receiving unit 6.

It is particularly advantageous if the piezoelectric device 4 combines the devices 2 and 3 in one element which both detects the acoustic signals and

also converts the detected acoustic signals into electrical signals bearing sound information. The piezoelectric diaphragm 8 with the surface acoustic wave resonance pattern, shown in figure 2, is used as the single element forming the device 4. In this case, the piezoelectric diaphragm 8 detects incoming acoustic signals in the manner of a pressure sensor. The standing wave in the piezoelectric element, which is excited by an excitation pulse from the receiving unit 6, is modulated by the acoustic signals so that the decaying vibration reflected back to the receiving unit 6 after the end of the excitation pulse bears the corresponding sound information. This makes it possible to provide a very rugged passive microphone for wireless transmission of sound information which has a simple and lightweight construction.

The microphone 1 according to the invention is constructed as a passive component, i.e. without its own power supply in the form of a battery or the like, since the energy of the excitation pulses from the receiving unit 6 is absorbed by the piezoelectric element, is stored and is used for transmitting the sound information.

To avoid heterodyning of the excitation signals with the signals bearing the sound information, transmitted by the microphone 1, the piezoelectric element is excited discontinuously, for example by a pulsed excitation signal. However, it is also possible to find advantageous continuous excitation signals. An impulse response in the form of a decaying vibration, which is extended over a very long period in the time domain, is generated, and transmitted back to the receiving unit 6, in particular, if the diaphragm 8 is a crystal diaphragm which has a very high Q factor.

Furthermore, the piezoelectric diaphragm 8 can essentially consist of lithiumniobate.

Instead of the piezoelectric diaphragm 8 with the surface acoustic wave resonant pattern, shown in figure 2, a surface acoustic wave delay line can also be used as the single element of the device 4. The surface acoustic wave delay line can both detect the acoustic signals and convert the detected acoustic signals into electrical signals bearing sound information.

If the piezoelectric device 4 is used for detecting the acoustic signals, a second piezoelectric device can be provided in order to provide for differential processing and conversion of the detected acoustic signals and thus to increase the sensitivity, for example for compensating for temperature fluctuations. If a separate device 2 for detecting acoustic signals is provided, a second device 2 for detecting acoustic signals can be provided in order to provide for differential conversion of the detected acoustic signals into electrical signals for the same purpose. In addition or as an alternative, a device for compensating for further disturbance variables can also be present.

As is shown diagrammatically in figure 1, the electromagnetic excitation energy can consist of discontinuous excitation pulses which are sent out by the receiving unit 6 and are correspondingly received by the microphone 1 according to the invention. The excitation pulses from the receiving unit 6 can be, for example, short high-frequency signals which, if necessary, are periodically repeated. It is of advantage in this arrangement if the excitation signal from the receiving unit 6 has a large bandwidth-time product. Another possibility is to use continuous frequency-modulated excitation signals.

Since the passive microphone 1 according to the invention is constructed in a very lightweight and rugged manner, it can be attached, for example, to a

spectacles frame. The antenna 5 of the microphone 1 can be formed, for example, by one of the earpieces of the spectacles or by the frame of one of the spectacle lenses. The microphone can be attached to the transition between the earpiece, used as antenna, and the spectacle lens frame. As an alternative, the microphone according to the invention can be attached to a holder which is detachably attached to the spectacle frame and which extends downward in the direction of the mouth of the wearer from the spectacle lens frame. In this case, the holder can be constructed as the antenna 5 of the microphone 1.

The passive microphone 1 according to the invention is also suitable for use in a wireless headset by means of which voice signals are transmitted to a telephone base station or a telephone mobile station. The microphone according to the invention can be constructed to be very lightweight and rugged which results in varied and specialized applications.

Patent claims

1. A passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6), comprising

- an antenna (5) for receiving electromagnetic excitation energy from the receiving unit (6) and for wirelessly transmitting electrical signals to the receiving unit (6) and
- a piezoelectric device (4),
  - which is connected to the antenna in such a manner that the electromagnetic excitation energy received from the antenna (5) is transmitted to the piezoelectric device (4) and stored by means of the piezoelectric device (4),
  - the piezoelectric unit (4) being designed in such a manner that detected acoustic signals are converted into electrical signals bearing sound information.

2. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 1, characterized in that the piezoelectric device (4) temporarily stores the excitation energy from the receiving unit (6) in the form of mechanical vibrations.

3. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 1 or 2, characterized in that the piezoelectric device (4) is used for storing the electromagnetic excitation energy, for detecting

acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information.

4. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in one of claims 1 to 3, characterized in that the piezoelectric device (4) essentially consists of a piezoelectric diaphragm (8) having a surface acoustic wave resonant pattern.

5. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 4, characterized in that the diaphragm (8) consists of crystal.

6. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 4, characterized in that the diaphragm (8) consists of lithiumniobate.

7. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in one of claims 1 to 3, characterized in that the piezoelectric device (4) essentially consists of a surface acoustic wave delay line.

8. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 1 or 2, characterized in that the piezoelectric device (4) comprises a device (2) for detecting acoustic signals and a device (3) for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information.

9. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 8, characterized in that the device (2) for detecting acoustic signals essentially consists of a diaphragm.

10. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 9, characterized in that the diaphragm consists of metal.

11. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 8, 9 or 10, characterized in that the device (3) for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information essentially consists of a diaphragm having a surface acoustic wave resonant structure.

12. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in claim 8, 9 or 10, characterized in that the device (3) for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information essentially consists of a surface acoustic wave delay line.

13. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in one of the preceding claims, characterized in that one or a further device for detecting acoustic signals is provided and is arranged in such a manner that the detected acoustic signals are differentially converted into electrical signals bearing sound information.

14. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in one of claims 1 to 13, characterized in that a device for compensating for disturbance variables is provided.

15. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in one of claims 1 to 14, characterized in that the piezoelectric device (4) receives the electromagnetic excitation energy from the receiving unit in the form of short high-frequency signals.

16. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in one of claims 1 to 15, characterized in that the piezoelectric device (4) receives the electromagnetic excitation energy from the receiving unit in the form of periodically repeated high-frequency signals.

17. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in one of claims 1 to 16, characterized in that the piezoelectric device (4) receives the electromagnetic excitation energy from the receiving unit in the form of excitation signals having a large bandwidth-time product.

18. The passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6) as claimed in one of claims 1 to 14, characterized in that the piezoelectric device (4) receives

the electromagnetic excitation energy from the receiving unit in the form of a continuous frequency-modulated excitation signal.

GR 99 P 1023

Abstract

Passive microphone with wireless transmission

The present invention relates to a passive microphone (1) for wirelessly transmitting sound information to a receiving unit (6), comprising a piezoelectric device (4) for receiving and storing excitation energy from the receiving unit (6) and for wirelessly transmitting electrical signals, converted from detected acoustic signals, to the receiving unit 6. Constructing the microphone (1) according to the invention as a passive component, i.e. without its own power supply, provides for a lightweight and, at the same time, rugged construction which results in considerable advantages, particularly in telephone applications.

(Figure 1)

09/889100

FIG 1

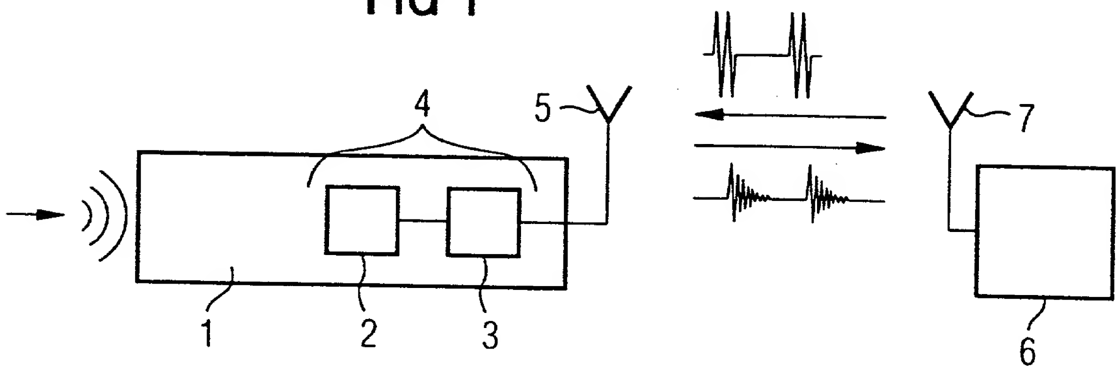
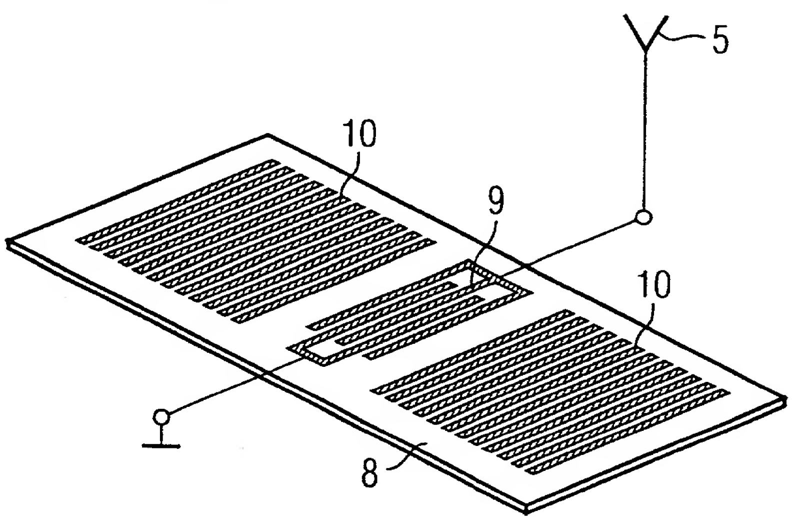


FIG 2



COMBINED DECLARATION FOR[illegible]ENT APPLICATION AND POWER OF [illegible]RNEY (Includes Reference to PCT International Applications) PCT/DE99/02524	ATTORNEY'S DOCKET NUMBER 112740-242

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

PASSIVE MICROPHONE WITH WIRELESS TRANSMISSION

the specification of which (check only one item below):

☐ is attached hereto.

☒ was filed as United States application
Serial No. 09/889,100

on July 11, 2001,

and was amended

on ______________________(if applicable).

☐ was filed as PCT international application

Number ______________________

on ______________________,

and was amended under PCT Article 19

on ______________________(if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT International application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Germany	19900633.4	11-01-99	☒ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

Combined Declaration For Patent Application and Power of Attorney (Continued) (Includes Reference to PCT International Applications) PCT/EP00/02524

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I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject mater of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS

U.S. APPLICATION NUMBER	U.S. FILING DATE	STATUS (Check one) PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.

PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)	PATENTED	PENDING	ABANDONED

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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DATE 5.11.01	DATE 7.11.01	DATE